PATENT SPECIFICATION (11) 1348623

1348623

(21) Application No. 1143/73 (22) Filed 9 Jan. 1973

(31) Convention Application No. 7201066 (32) Filed 13 Jan. 1972 in

(33) France (FR)

(44) Complete Specification published 20 March 1974

(51) International Classification C01D 11/02

(52) Index at acceptance

C1A D62 D63 G44 G44D62 G44D63

H1E 1

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(54) CRYSTALS OF LITHIUM SALTS HAVING EXCELLENT STABILITY IN A NEUTRON FLUX

(71) We, COMMISSARIAT A L'ENERGIE ATOMIQUE, an organisation created in France by ordinance No. 45—2563 of 18th October 1945, of 29 rue de la Federation, Paris 15e, France, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

This invention relates to piezoelectric materials of use as transducers in a neutron flux.

The piezoelectric materials according to the invention are characterised in that they comprise crystals of lithium salts selected from the group comprising lithium niobate and lithium tantalate wherein the lithium has a lithium 7 isotope content greater than that of natural lithium.

According to one advantageous feature of the invention, the lithium 7 isotope content is greater than 99%.

Lithium tantalate ($LiTaO_3$) and lithium niobate ($LiNbO_3$) are, of course, materials with a wide range of applications not only in low and average temperature areas, but also in high-temperature applications, because they have a number of properties not found in combination in any other material (for example ferro-electric, optical, piezoelectric elastic and other properties).

More particularly, they have the following properties:

1. A high electromechanical coupling coefficient. The electromechanical coupling coefficient, of course, is an indication of the efficiency of conversion of mechanical energy to electrical energy and vice-versa.

2. A very high maximum operating frequency of the order of 2.10^9 Hz, this high frequency being the starting point in the development of the delay lines used in telecommunications.

Lithium tantalate and lithium niobate have good stability to α, β and γ radiation; they also have a relatively good stability in a neutron flux, but only when the instantaneous and integrated flux, and the neutron energy used, do not exceed a certain value.

The object of the invention is greatly to improve the stability of these substances in a neutron flux, more particularly when they are used as piezoelectric materials in transducers, deformation, swelling and final breakdown of the lithium niobate or tantalate crystals being avoided.

Up till now, the lithium used for the production of crystals of lithium salts was natural lithium, i.e. lithium formed from 7.4% of Li 6 and 92.6% of Li 7. The isotope Li 6, which has an absorption cross-section of 945 barns to thermal and epithermal neutrons (i.e. 23000 times greater than that of Li 7), is responsible for most of the damage undergone by the crystals under the action of a neutron flux. The reason for this is that the reaction Li 6 (n α) used for the production of tritium also produces helium:

$$Li\ 6 + ln \rightarrow He^4 + H^3$$

and the formation of bubbles of gas within the lithium niobate or lithium tantalate crystals, the resulting pressure increase, and then the coalescence of these bubbles of gas result in an increase in the internal stresses in these crystals, which swell and finally burst, because they are very fragile materials, and such phenomena, of course, occur even more rapidly as the instantaneous neutron flux increases.

In the specific case in which the lithium niobate or lithium tantalate crystals are used as piezoelectric materials for transducers, a formation of tritium and helium bubbles in this way and the swelling of the crystals are responsible for a considerable reduction in the qualities of such transducers (sensitivity, frequency, resolving power and so on) and even if crystal breakdown does not occur there is a 30 db sensitivity loss for the following integrated flux values:

1.10^{19}nvt (thermal)

$1.25 . 10^9$nvt (fast)

The invention obviates the various disadvantages resulting from a neutron flux, by the use of Li 7-enriched lithium.

By way of example, if lithium formed by 99.99% of Li 7 is used for the formation of the crystals of lithium salts, the above-indicated damage produced by a neutron flux is reduced in a ratio of about 1000.

The materials according to the invention can operate at high temperature and are therefore very advantageous for use in nuclear reactors particularly for the following:

Ultrasonic testing: location of faults (cracks, corrosion, fatigue) of noise emitting sources;

The monitoring and measurement of levels, pressures, rates of flow, vibration etc.,;

The production of strain gauges based on the piezoelectric or piezoresistive effect.

WHAT WE CLAIM IS:—

1. Piezoelectric materials of use as transducers in a neutron flux, characterised in that they are formed by crystals of lithium salts selected from the group comprising lithium niobate and lithium tantalate in which the lithium has a lithium 7 isotope content greater than that of natural lithium.

2. Materials according to Claim 1, characterised in that the lithium 7 isotope content is greater than 99%.

3. Piezoelectric materials substantially as hereinbefore described.

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Printed for Her Majesty's Stationery Office, by the Courier Press, Leamington Spa, 1974.
Published by The Patent Office, 25 Southampton Buildings, London, WC2A 1AY, from which copies may be obtained.